THESIS

Influence of Temperature and Acidity Upon the Quality of Butter

R.L. Brown.
1901

Butter

T H E S I S .

A S T U D Y O F T H E I N F L U E N C E O F T E M P E R A T U R E A N D A C I D I T Y U P O N T H E Q U A L I T Y O F T H E B U T T E R W H E N R I P E N E D W I T H X B A C I L L U S A C I D I L A C T I C I.

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A Study of the Influence of Temperature and Acidity upon the Quality of the Butter When Ripened with x Bacillus Acidi Lactici.

The object of the experiment is to determine in the case of x Bacillus acidi lactici the best temperature and the most suitable amount of acid for the ripening of cream in the production of the best quality of butter.

The purpose was to study the effect of temperature and acidity on the quality of the finished product. The temperatures at which the cream was ripened were within the range of 60° to 80° F. The acidity was studied only under the most satisfactory temperatures determined above and in variable amounts.

In order to get cream free from differences that might arise previous to the experiment, it was kept in one vat and well mixed until divided for ripening. A control or naturally ripened sample was used in each case, with which to compare any change or abnormal condition in the inoculated sample. In the first series a third sample ripened with some standard commercial starter was also used as a further check upon the work. In the second series, however, the commercial starter was

omitted and only the naturally ripened check was used.

The results of the test were determined from scores made by competent butter judges. The first score was made soon after the second working and the second after storing for four weeks.

The Starter.

The x Bacillus acidi lactici used was a rapid grower and produced a good firm curd free from gas, but gave a rather strong caramel flavor. This flavor was not regarded as detrimental to the experiment in as much as good starters were used, and as it is as easy to detect any change in a bad flavor as a good one. The starter was prepared by sterilizing milk in flasks having cotton wool stoppers, and then inoculating with the desired culture.

First Series.

The cream was taken either from the milk of the College herd or from that bought of H. A. Smith, of Tikom. Each churning consisted of 2½ or 3 pounds, testing between 23% and 29% fat. The cream for each comparison was taken as one sample from the same vat, thoroughly mixed and tested for fat and acid. From this sample a portion was put in a

can for natural ripening. The remaining cream was then thoroughly pastuerized and cooled to the ripening temperature. A fixed amount was then put in each of two glass cans, and inoculated, one with x B. acidi lactici starter, and the other with one of the commercial lactic acid starters. The three cans, with the covers placed on loosely, were put in a large Boyd ripener containing water at the desired temperature of ripening. With this arrangement it was found possible to keep the temperature within the range of five degrees for twenty-four hours.

When the ripening had progressed sufficiently the cream was cooled and churned. This was done by cans of a swing churn arranged for churning the three samples simultaneously. This was devised to eliminate the differences in churning, but was found unsatisfactory, and in the latter part of the experiment shaking was resorted to with better results.

The butter was washed twice, salted, worked and placed in the refrigerator to allow the salt to dissolve, and then reworked and printed. After giving time to harden, it was scored independently by Mr. John Michels and Mr. J. J. Ferguson. The butter was wrapped in parchment paper and kept in an ordinary refrigerator for four weeks until

the second scoring.

In the accompanying table is given a summary of the work done. As unavoidable changes in the temperature during churning and working would probably make more difference in the grain and texture, the flavor was taken as the main basis of comparison. The temperatures at which the cream was ripened as given in the table, are taken from the water about the cans; for the cream was brought to nearly the same temperature as the water and would assume that temperature in a short time. The change of temperature during ripening is given to show how nearly the temperature conformed throughout to what was desired.

The kinds of starter used were the x Bacillus acidi lactici (H.), Keith (K.) Douglas (D.) and Hansen (H.). The x B. acidi lactici being the basis of the work was used in each trial and the commercial starters only for comparison.

Table Showing a Summary of the Work Done In Determining the Best Temperature.

Sample No.	Temperature Ripened	Fall during Time of Ripening	Fat %.	Acidity Degrees	Kind of Starter	Michels 1st score	Michels 2nd score	Ferguson 1st score	Ferguson 2nd score
A_1	82	1°	23	52	M.	41	39	40	35
A_2	82	1°	23	64.4	K.	46	42	38	40
A_3	82	1°	23	45.6	–	44	38½	43	35
B_1	80	9°	29	54	M.	37	–	28	–
B_2	80	9°	29	52	M.	36	–	30	–
B_3	80	9°	29	67	D.	40	–	35	–
C_1	66	2°	26	55	M.	42	42	34	38
C_2	66	2°	26	61	M./D.	42	41	44	42
C_3	66	2°	26	39	–	39	40	42	40
D_1	61	1°	24½	67	M.	41	41½	32	42
D_2	61	1°	24½	61.5	D.	45	42	40	36
D_3	61	1°	24½	66.5	–	44	43	42	35
E_1	67	6°	23	55	M.	44	40	35	33
E_2	67	6°	23	(68)	D.	44	42	38	44
E_3	67	6°	23	57	–	41	40½	43	35
F_1	70	6°	28	71	M.	43	37	35	30
F_2	70	6°	28	74	M.	44	36	45	38
F_3	70	6°	28	71.5	–	40	30	42	33
G_1	60	-1°	26	78	M.	44	37½	35	40
G_2	60	-1°	26	82	D.	44	43½	45	42
G_3	60	-1°	26	66	–	42	38	40	35

The scores of the butter ripened at the same temperature were then averaged and arranged according to temperature, to bring the result into a more general form for easy comparison.

Averages of Scores, Arranged According to Temperature, On the Basis of Flavor Alone.

	First Score.				Second Score.			
Temperature.	" 80	" 70	" 66-7	"60"	80	" 70	" 66-7"	60 "
	"	"	"	"	"	"	"	"
x B.acidi	"	"	"	"	"	"	"	"
lactici	"35.3"	39	"38 3/4"	"38"	37	"33½	" 38.3"	"40.3"
	"	"	"	"	"	"	"	"
Commercial	"39 3/4	44.5	41	"43½	41	"34	" 43	"40.9"
	"	"	"	"	"	"	"	"
Natural	"43.5"	41	"41 1/4"	"42"	36.7	"31½	" 38.9"	"37.8"

From this comparison of the averages a fair indication can be had of the flavor produced as dependent upon the temperature of ripening. The result though indicative is not entirely conclusive, because of the limited number of trials. The result either in the first or second scoring fails to bring out the superiority of any one temperature between 60° and 80° F.

For further comparison, another table of averages was prepared similar to the first, including the texture score, with the flavor. As in the preceding table, the differences in the score are not sufficient to indicate a superiority of any one temperature.

Averages of Scores, Arranged According to Temperature, On the Basis of Flavor and Texture.

	First Score.			Second Score.			
Temperature.	"60	"70	"66-7"	60 "	80 "	70 "	"66-7"	60 "
x B.Acidi lactici	"63	"66	"67.6"	"66	"64.5	"61.5"	"66.5"	"66.9"
Commercial	"70	"71.5	"70¼	"70¼	"69	"65	"70.8"	"68.5"
Natural	"72	"66	"68½	"70.4"	"64.5	"59.5"	"66.6"	"64.5"

The result of the experiment, then is that there is at least no marked superiority of a certain temperature within the limits of 60° and 80° F., and that just as good results may be obtained from cream ripened at 80° as at 60° F., if properly managed. This must, however, be taken with the limitations of the experiment, for work with other germs or tainted cream might produce materially different results. The final score makes no material change nor shows a preference for any particular temperature.

Second Series.

The ripening temperatures in the second series were chosen between 60° and 72° F. Three trials were arranged; one ripened at 60°, one at 68°, and one at 72° F. The cream was taken from the college milk, thoroughly mixed and tested for fat and acid. In each of the two cans used enough cream was placed for four churnings. One can was pasteurized and inoculated with x B. acidi lactici, the other al-

lowed to ripen naturally. The commercial starter was omitted in this test.

The ripening was conducted in the same Boyd ripener as in the previous part of the experiment. The plan was to make churnings at different acidities ranging from .24% to .62%.

When the ripening had advanced sufficiently a sample was taken from the can and churned. In this way approximately similar conditions were obtained for each, except the bacterial action in connection with the development of the different amounts of acid. From this point forward the treatment was the same as in the previous part of the experiment.

A summary of the work done is given in the following table.

Table of Results of the Canning at Different Acidities.

Sample.	Number of days aging.	% Acidity 1st. .28-.34	2nd. .38-.45	3rd. .48-.54	4th. .58-.62	Nichols 1st score	Nichols 2nd score	Ferguson 1st score	Ferguson 2nd score
M.1	"62 "	.34 "	"	"	"	" 42	" 41	" 35	" 38 "
2 M.1	"62 "	"	".44"	"	"	" 40	" 39	" 40	" 42 "
3 M.1	"62 "	"	"	"	".57	" 42	" 42	" 35	" 41 "
4 M.1	"62 "	"	"	"	".60	" 42	" 41	" 38	" 43 "
M2	"66 "	.38 "	"	"	"	" 41	" 39	" 39	" 40 "
2 M2	"66 "	"	".45 "	"	"	" 42½	" 42	" 40	" 40 "
3 M2	"66 "	"	"	"	".57	" 41½	" 39	" 38	" 43 "
4 M2	"66 "	"	"	"	".58	" 43	" 38	" 42	" 43 "
1 M3	"72 "	.31 "	"	"	"	" 43	" 38	" 35	" 36 "
2 M3	"72 "	"	".46 "	"	"	" 41	" 37	" 35	" 38 "
3 M3	"72 "	"	"	"	".60	" 44	" 40	" 43	" 40 "
4 M3	"72 "	"	"	"	".62	" 41½	" 38½	" 34	" 35 "
N	"62 "	"	"	.48 "	"	" 42½	" 37	" 44	" 38 "
2 N	"62 "	"	"	.56 "	"	" 42	" 39	" 40	" 44 "
3 N	"62 "	"	"	"	".59	" 44½	" 42	" 43	" 45 "
4 N	"62 "	"	"	"	".61	" 44	" 44	" 35	" 43 "
N2	"66"	.31 "	"	"	"	" 45	" 39½	" 41	" 42 "
2 N2	"66 "	"	"	.53 "	"	" 45½	" 41	" 38	" 41 "
4 N2	"66 "	"	"	"	.58	" 46½	" 43	" 37	" 45 "
N3	"72 "	.35 "	"	"	"	" 40	" 36	" 38	" 38 "
2 N3	"72 "	"	.42"	"	"	" 43	" 37	" 34	" 43 "
3 N3	"72 "	"	"	.53"	"	" 44	" 37	" 43	" 40 "
4 N3	"72 "	"	"	.56"	"	" 41½	" 40	" 43	" 40 "

From this table was prepared an average of the scores of both judges,—first upon the flavor alone, and then upon flavor and texture. To facilitate the comparison, the averages were then arranged in order according to the different acidities.

Table of Averages, Comparing Samples on the Basis of Flavor, and Flavor and Texture.

x B. Lactici Acidi Starter.

Acidity	.28-.34	.38-.45	.48-.54	.57-.62
First Scoring.				
Flavor	39.1	39.7		40.3
Flavor and Texture	67.3	68		68.9
Second Scoring.				
Flavor	38.7	39.7		40.8
Flavor and Texture	67.3	67.8		68.4

Natural Ripening.

Acidity	.28-.34	.38-.45	.48-.54	.57-.62
First Scoring.				
Flavor	41.	38.5	42.3	41.8
Flavor and Texture	69.2	67	70.3	70.2
Second Scoring.				
Flavor	38.4	39.5	39.6	43.3
Flavor and Texture	68.3	67.5	67.5	72.3

The result of the work is slightly in favor of the higher acidities, both as to flavor and keeping qualities. Though some of the milder acidities gave a

fine mild flavor, and scored high on the first scoring, they deteriorated more than the more strongly acid ones before the second.

The results of the work may, then, be summed up in the following statements, viz:

1. That within the range of 60° to 80° F., the temperature has no marked influence upon the flavor, and no superior specific temperature can be located.

2. That within a range of .43% to .66% acidity in the cream the flavor and keeping quality of the final product was slightly improved.

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